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ABSTRACT

The multivariate approach of canonical correlation was used to assess selection procedures of the Air Force Academy. It was felt that improved student selection methods might reduce the number of dropouts while maintaining or improving the quality of graduates. The method of canonical correlation was designed to maximize prediction of academic performance, military performance, and attrition. High school course and grade information, scores on the Admissions Testing Program Verbal and Mathematics Aptitude Tests, a physical aptitude measure, an athletic activity index, and an index of nonathletic extracurricular activities were analyzed for 257 individuals. The criterion variables were cumulative grade-point average at the end of the freshman year, an index of military performance, and a zero-one attrition variable that identified subjects who left the Air Force Academy after their freshman year. Findings are discussed, and it is concluded that the selection process can be improved by using additional data from standard high school transcripts and modifying weights of current selection variables. (SW)

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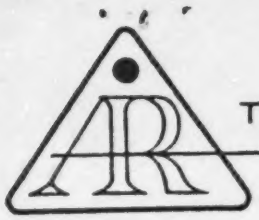

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INTEGRATING MULTIPLE CRITERIA IN SELECTION PROCEDURES FOR IMPROVING STUDENT QUALITY AND REDUCING COST PER GRADUATE

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INTEGRATING MULTIPLE CRITERIA IN SELECTION PROCEDURES FOR IMPROVING STUDENT QUALITY AND REDUCING COST PER GRADUATE

This paper addresses the problem of reducing the cost of operating an institution of higher learning while maintaining the same number of graduates. The approach used was to examine the feasibility of reducing the number of dropouts while maintaining or improving the quality of graduates through the use of improved student selection methods. Graduate quality was measured with an academic performance variable and an index of student military performance, both of which are related to graduate success as a military officer. Canonical correlation was used to provide a simultaneous evaluation of the three criterion variables and an extensive set of predictor variables. Both the method and findings will be useful to planners and researchers.

The increasing budgetary constraints imposed on public institutions create a challenge to do still more with present resources. The prospect of these constraints abating is not likely in the face of ongoing sociological processes that shift an increasing tax burden to a decreasing proportion of the population who are becoming increasingly concerned and active.

Universities constitute one public sector element that is being asked to achieve greater operating economies to reduce the tax burden. One approach for accomplishing this at an institution such as the United States Air Force Academy is to reduce attrition while continuing to educate a relatively fixed number of high-quality graduates each year. The value of such an approach is that resources could be saved that are currently expended to house, feed, clothe, educate, and maintain the attritees. These expenditures constitute a large percentage of the approximately $90,000 it costs (according to General Accounting Office reports in the media) for each graduate. Hence, with current attrition rates close to forty percent, it is logical that a large monetary saving may be achieved through improved selection methods.

The Air Force Academy's concern, however, as with all institutions of higher learning, is with the quality of the graduate as well as attrition. Quality at the Air Force Academy is measured by two methods that provide more information than can be obtained in most nonmilitary institutions: One method uses the traditional grade point average. The second quality measure provides data about a student's military performance. Since both measures have been shown to be related to later officer performance, any selection measures adopted must consider their impact on these quality measures.

The present Air Force Academy selection procedures (based upon a series of multiple regression analyses) combine statistically weighted objective and subjective data to yield selection scores that determine which candidates are selected. Included are Admissions Testing Program and American College Testing Program data, information derived from personal interviews, rank in class, evidence of achievements and awards, and curricular and extracurricular activity information.

To further improve selection, it seemed necessary both to consider readily available additional data that are not presently used, and to try different analysis techniques. One type of data that is not explicitly used in the current selection process is high school course information. Although the present procedure uses rank-in-class data, it does not include information on type and number of high school courses taken or the grades achieved. Research suggesting that such information may be useful for improving selection procedures is provided by a number of writers. Judy (1965) for example, reported that using high school course information increased validity coefficients. Brokaw (1963) found that the inclusion of education data improved predictions of technical school success. Finally, Travers (1949) in his review of over 200 studies found that high school course information surpassed subject matter and psychological tests as predictors

of college grades.

These well established facts were the basis for a previous study by Judy and Westen (1971). Their study demonstrated that information on particular high school courses and grades achieved improved prediction of academic achievement at the Air Force Academy. However at the time, the gain realized (as shown by an increase in a multiple correlation coefficient from 0.55 to 0.59) did not seem to merit the additional effort required to process the applicants' transcripts.

Given the above, the purpose of this research was to use the multivariate approach of canonical correlation to assess the relationship between the three criteria and a set of predictor variables. The first goal was to determine the potential improvement in prediction of academic, military performance criteria and attrition by the inclusion of specific high school course and grade information in combination with available data. The second goal was to validate current selection procedures, and the third was to identify areas for potentially fruitful future research.

METHODOLOGY

Sample

Of the 1,593 students who entered with the class that will graduate in 1980, 257 were the subjects of this study. They were randomly selected with the additional qualifications that their high school transcript could be interpreted in terms of previously identified high school courses, that they had scores on the Admissions Testing Program (ATP) Verbal and Mathematics Aptitude Tests, and that they had completed at least one year at the Air Force Academy. This latter qualification insured that performance criterion data were available for all subjects.

Variables.

Data for the independent variables consisted of course and grade information extracted from high school transcripts and other variables. The basic high school course unit was a single foreign language, English or literature, mathematics, science, or social studies course taken for one semester. The subjects received a score of 40 for an "A" grade, a score of 30 for a "B" grade, etc. Not taking the course or failing resulted in a score of zero. The results were, as one might have predicted, almost useless in their original form, since the matrix of high school coursegrade data had so many entries. To derive meaningful data, composite scores for all foreign language courses for an individual were added together to form a "language total." Similar composites were derived for science, mathematics, English and literature, and social studies courses. The resulting sets of scores tended to be normally distributed within the sample. The major exception to this was the distribution of the foreign language total score which had a relatively high frequency of zero scores.

The remaining independent variables consisted of the previously described ATP test scores, a physical aptitude measure, an athletic activity index and an index of extracurricular activities based on nonathletic activities such as participation in student government, debate teams, dramatics, band, etc.

The criterion variables were cumulative grade point average at the end of the freshman year, an index of military performance, and a zero-one attrition variable that identified subjects who left the Air Force Academy after their freshman year.

Data Analysis

Canonical correlation was used to analyze the data. Its use in this research was particularly appropriate because a principle goal was to simult-

aneously maximize prediction of academic performance, military performance, and attrition. Since canonical correlation simultaneously considers the dependent variables, it overcomes the limitations of a multiple regression approach that individually considers the effect of the independent variables on only one dependent variable. (For a further description of canonical correlation and a good computer program, see Warwick (1975).)

RESULTS

The literature on canonical analysis (see, for example, the previously cited article by Warwick) emphasizes that canonical variates may not be psychologically meaningful, but the present example seems to be fairly clear. As Table 1 shows, two statistically significant canonical variates were identified, and the predictors in the first canonical variate set, correlated 0.53 with the criterion variance in that set.

Insert Table 1 about here

The eigenvalue shows that the first canonical variate accounted for 28 percent of the criterion variance. Statistically orthogonal to, or independent of the first canonical variate, the second canonical variate correlated .32 with the criterion subset.

Insert Table 2 about here

The entries in Table 2 are correlation coefficients showing the relationship between the canonical variates (which are similar to principal component factors) and the original variables. The patterns of high correlations serve to identify the obtained variates quite well. The first variate is

TABLE 1

Canonical Correlation

Canonical Variate	Eigenvalue	Canonical Correlation	D.F.	Significance
1	.28	.53	.27	.001
2	.10	.32	16	.01
3	.03	.16	7	.50

TABLE 2

Coefficients for Canonical Variables

Predictors	Canonical Variate 1	Canonical Variate 2
H.S. Language	.10	.11
H.S. English	.09	.32
H.S. Science	.31	.00
H.S. Math	.11	.51
ATP Verbal Aptitude	.36	.05
ATP Math Aptitude	.29	.08
Physical Aptitude	-.22	.15
H.S. Athletic Index	-.29	.81
H.S. Extracurricular Activities Index	-.06	.12
Criteria		
Grade Point Average	.95	.23
Military Performance	-.26	.87
Attrition-Retention	.27	-.34

clearly identified with academic achievement and academic aptitude, while the second is clearly related to the leadership criterion, the Athletic Activities Index, and variance in the High School Mathematics Course scores.

The attrition-retention criterion was significantly correlated with both canonical variates; retention was positively related to the academic achievement variate and negatively related to the leadership variate. The attrition-retention criterion did not form a third variate apparently because there was too little remaining correlated variance after the first two variates were extracted.

DISCUSSION

The findings associated with the first canonical variate were expected; past academic achievement and ATP scores are usually associated with college grade point averages. In addition, Air Force Academy research has shown that both athletic achievement in high school and athletic aptitude tend to be negatively related to Academy grade point averages. The chief unanticipated result was the finding of a .51 correlation between high school mathematics course scores and the second canonical variate that is clearly related to leadership. One explanation for this finding may be that high school students who are motivated to come to the Air Force Academy are encouraged to enhance their chances by taking extra mathematics courses and excelling in sports. This explanation is supported by the fact that freshmen have little opportunity to demonstrate leadership in other than athletic competition, since members of the upper classes do most of the leading while freshmen are primarily followers. Clearly, a follow-up of the current study is required that will analyze the present subjects' leadership evaluations in later years after they have had opportunities to exercise leadership and control in a variety of cadet functions.

The other unanticipated finding was the negative relationship between

retention and freshman leadership evaluations. It may be that the best athletes who tend to be identified as the best leaders during the freshman year, are also most likely to leave and accept scholarships at other institutions.

Finally, because of multicolinearity problems it proved necessary to remove from the computations a prior academic record variable that is presently used in the cadet selection process. In order to evaluate whether using the high school course variables rather than the prior academic record score added to the prediction of academic achievement it was necessary to make a subjective judgment. At this point it appears that using high school course scores rather than the prior academic record score improves prediction of academic success, but only slightly and the difference is again in the same range as that noted in the Judy and Westen study. Additional research is required to determine the degree of improvement.

CONCLUSIONS

The present study suggests that the Air Force Academy's selection process can be improved by utilizing additional data from standard high school transcripts and modifying weights of current selection variables. Although the time required to code the high school transcripts used in the study still results in a less than cost-effective procedure, other means may be developed to provide the course and grade data.

The data also suggest that leadership measured during the freshman year is primarily related to physical aptitude and athletic achievements and is negatively related to retention. This calls out for additional study and particular investigations of whether or not leadership in upper class years exhibits a similar pattern of relationships.

Canonical correlation analysis proved to be particularly useful in this

situation where there were multiple criteria of success. While the present study emphasized the three criteria used at the Air Force Academy, the techniques of canonical analysis should also prove useful at other institutions concerned about GPA and attrition criteria. At the same time the authors would suggest that most colleges and universities are concerned with measures of student behavior beyond attrition and GPAs although most research on success in higher education has focused upon academic success measured by these criteria. At the same time, college and university catalogs commonly provide statements of institutional goals or objectives which imply that they seek to produce changes in many kinds of student characteristics or behaviors in addition to the academic competence reflected by grades. An outstanding example of research designed to consider some of these other aspects of student behavior and to predict them is the monograph by Anastasi, Meade, and Schneiders (1960). Perhaps difficulties involved in the development of criterion measures other than grade point averages or graduation-attrition tallies have led most researchers to concentrate on the more readily available criteria, yet there is little doubt that noncognitive behaviors are of significance to many institutions other than the service academies.

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